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PHYSICAL ATTRIBUTES OF THE SOIL IN DIFFERENT USES IN THE CERRADO BIOME

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Abstract: The characterization of the physicochemical fertility of the soil profile is important for a more informed interpretation of the need for interventions to promote better plant development. The objective of this work was to determine the physicochemical quality of surface horizons in a degraded pasture system, planted forest, conventional cultivation and regenerating cerrado. Sample collections were carried out in the experimental units of the Agrarian Sciences Complex (CCA) of the State University of Tocantins - Unitins, Palmas - TO, in the lower third of the Tocantins River basin - Lago de Palmas region. Deformed samples were collected for chemical and textural characterization of each area of use, as well as undisturbed samples to determine the physical parameters. The sample results were subjected to principal component analysis in order to summarize the information contained in the original data matrix. The best physical conditions, in general, were found in the area with cerrado in regeneration, due to the more sandy texture of the soil, and the best chemical quality, in the planted forest area. As for the areas of use system of degraded pasture and conventional agricultural cultivation, there was low physical quality with great compaction in the former, in addition to both presenting unfavorable chemical characteristics. Thus, land use strongly influenced the physicochemical attributes of the soil.
Keywords: Areas of use, superficial horizons, anthropization.

INTRODUCTION

The management and use of the soil, without prior assessment of its potentials and limitations, has been the reason for the degradation of natural resources, such as soil and water, which are fundamental for human survival. It is estimated that 40% of the agricultural lands in the world suffer degradation (DUMANSKI & PIERI, 2000).

The continued use of different management systems determines changes in soil properties, whose intensity depends on the time of use and edaphoclimatic conditions. Physical properties are more affected by tillage systems, with different responses in terms of crop growth and production. Soil preparation is the management practice that most changes the physical properties of the soil and its effect depends on the implement used, the intensity of use and the moisture condition at the time of operations (VEIGA, 2005; SOUZA et al., 2001).

Inappropriate management can lead, among other situations, to soil compaction. This fact has been pointed out as one of the main indicators of degradation and cause of a decrease in crop productivity (STONE & SILVEIRA, 2001).

Also according to Stone and Silveira (2001), compaction is a consequence of practices such as soil turning, excessive machine traffic and/or inadequate water conditions at the time of preparation, overcrowding of animals, among other situations. The main changes are the decrease in macro pore volume, aggregate size, water infiltration rate into the soil and increased resistance to root penetration and soil density (CAVENAGE et al., 1999).

Soil quality monitoring must be aimed at detecting changing trends, especially in order to indicate the first stages of change, without severe soil degradation. This monitoring can be done on the agricultural property. Soil and water management and conservation practices must be planned and executed, seeking to maintain or even improve their attributes, in order to increase the soil's capacity to sustain competitive productivity, without compromising water quality (ARAÚJO et al., 2007).

This way, evaluating production systems at depths greater than the usual 0-20 cm can reveal information that could be a key factor for better plant development and, consequently, higher productivity.

MATERIAL AND METHODS

The samplings were carried out in experimental units in the area of the Agrarian Sciences Complex (CCA), which the State University of Tocantins – UNITINS is part of, in the municipality of Palmas – TO. The coordinates are latitude 10° 12' 46" S and longitude: 48° 21' 37" W, in the lower third of the Tocantins River basin – Lago Palmas region (Figure 1).

According to data from Seplan (2012), the municipality of Palmas is under a humid tropical humid climate (C2wA'a") with moderate water deficit in winter, average annual potential evapotranspiration of 1,500 mm, distributing in summer around 420 mm over the three consecutive months with the highest temperature. Its biome is the cerrado, with more than five dry months. The average annual precipitation and temperature in Palmas remain around 1,800 and 1,900 mm and 29°C, respectively.

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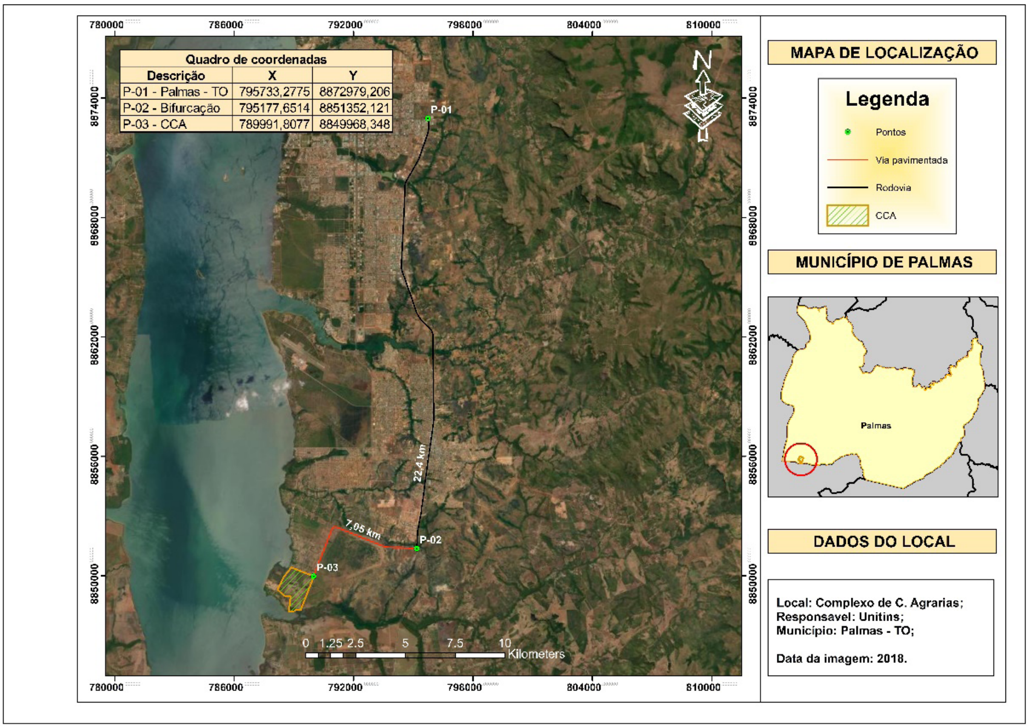

Figure 1. Location of the study area: Palmas, Tocantins – Brazil.

The treatments consisted of an area with degraded Urochloa (Urochloa sp.) pasture, Eucalyptus (Eucalyptus sp.) forest planted 5 years ago, an area with conventional agriculture (plowing and harrowing) and an area of cerrado in regeneration. Soils are classified according to the Brazilian Soil Classification System (SILVA, 2014). The pasture area, Eucalyptus sp. and the conventional cultivation area were classified as concretionary dystrophic Red Yellow Latosols, typical Dystrophic Yellow Latosols and argissolic Red Yellow Aluminium Latosols, respectively.

Undisturbed samples were collected in all areas to determine the physical parameters, using steel rings (kopecky rings) of known volume (53.8 dm^3), with three samples for the surface horizons of each area of use. Then, deformed samples were collected for chemical and textural analysis of the surface horizon of each profile (SANTOS et al, 2013).

After collection, the samples were sent to the University's soil physics laboratory to carry out the following analyses: hydraulic conductivity, soil density and total porosity according to the methodology detailed in Embrapa (2017). Regarding the evaluation of chemical attributes, the samples were taken to the Laboratory where they were air-dried and later passed through 2 mm sieves, to obtain the fine earth. Subsequently, they were submitted to chemical (Ca2+, Mg2+, K+, P, V%, m%, CTC, pH in water) and particle size (sand, silt and clay) analyzes. Soil pH, exchangeable acidity (Al^3), exchangeable P, K+, Ca2+ and Mg2+ contents, potential acidity (H + Al^3+), saturated organic matter (MOS) and organic carbon (C) were determined according to methodology presented by EMBRAPA (2017). From the values of potential acidity, exchangeable bases and exchangeable aluminum, the sum of bases (SB), the cation exchange capacity (CTC), the percentage of base saturation (V%) and the percentage of saturation by base were calculated. aluminum (m%).

The physical and chemical attributes of the soil were subjected to principal component analysis in order to summarize the information contained in the original data matrix. This analysis was conducted by extracting eigenvalues and eigenvectors from the correlation matrix (pxp) between the soil variables present in the original matrix consisting of 16 descriptors (DS, PT, KS, UV, Clay, Silt, Sand, P, K+, V%, m%, MO, CTC, Ca2+ + Mg 2+, Al^3+ and pH) and 20 observations for each treatment (samples).

The study of soil quality through indicators can be carried out using statistical techniques of multivariate analysis (BENITES et al., 2010). The use of multivariate analysis allows evaluating a set of attributes and revealing independent results in the form of quality indices (MARCHESAN et al., 2011). The amount of information extracted from each main component was measured using eigenvalues, assuming as informative those with a value greater than one. Thus, it is assumed that the scores of the main components represent the original data, in a summarized way, condensing the original information into a new combination of data that is strongly associated with a certain set of original variables. The analysis was performed using the Past 3.x program (HAMMER et al., 2001).

RESULTS AND DISCUSSIONS

All principal components had their eigenvalues greater than one, with the first accounting for 50.59% of the total variance found in the data set. If added to the second principal component, together they account for 84.31% of the original extracted variance (Table 2).

Main component	Values (λ)	% of the variance	% variance cumulative
λ_1	8.094	50.59	50.59
λ_2	5.395	33.72	84.31
λ_3	2.510	15.69	100.00

Table 2. Results of applying principal component analysis on the correlation matrix between descriptor variables (physical parameters of soils).

The first two main components were responsible for segregating the areas into two distinct groups. The first component responds to the variances of pasture and agricultural areas, while the second component responds to the more conservative environments, planted forest and cerrado in regeneration (Figure 2). Below is the matrix of correlation coefficients between eigenvectors 1, 2 and 3 and the original variables described in table 3.

Soil density was positively correlated with axis 1 (0.043) and with axis 2 (0.256). The high soil density (SD) verified in the degraded pasture area is related to the practice of cattle raising. According to studies by Stone & Silveira (2001), surface compaction is a consequence of practices such as animal overcrowding, as well as the non-maintenance and conservation of pastures, leaving bare soil subject to the actions of bad weather.

The attribute total porosity (PT) presented a positive correlation coefficient for Axis 1 (0.332) and negative for Axis 2 (-0.052), thus, it fit in the diagram in the agriculture area. The intensive soil tillage in agricultural areas, using a harrow and other implements, causes the soil to be sprayed on the superficial horizons and increases the soil macroporosity, which indicates the highlight in total porosity (PT) and volumetric moisture (UV). The soil spraying on the surface layer is harmful to the soil and can cause erosion, causing loss of chemical nutrients and textural colloids (clay) by leaching and subsurface erosion (STONE & SILVEIRA, 2001).

The agricultural area also stood out due to the strong presence of aluminum in its solution, indicating that the constant agricultural use, without considering the maintenance of correctives in the soil, influenced this result. The accumulation of organic matter is caused by the decomposition of crop residues and weeds, indicating an increase in C.T.C. due to organic colloids (AQUINO et al. 2005)

The soil hydraulic conductivity (KS) showed a negative correlation coefficient with Axis 1 and 2, with values being -0.209 and -0.343 respectively, thus, it fell within the regenerating cerrado area, this fact can be explained by the soil from the regenerating cerrado area has been morphologically classified as Quartzarenic Neosol, while the soil from other areas was morphologically classified as Oxisol. The result is in accordance with the studies by Fiori et al. (2010), who evaluated the KS in 5 groups of soils in the state of Goiás, and found greater hydraulic conductivity in the Quartzarênico Neosol.

The results of the textural attributes, clay, silt and sand, showed a greater correlation of sand in the regenerating cerrado area and a greater correlation of silt and clay in the degraded pasture area, however, what explains these results, are soil types of the areas, being Neosol for the regenerating cerrado area and Oxisol for the other studied areas. It is known that clay, silt and sand is a particle size classification. Oxisols are well-structured and consistent soils, a consequence of the presence of clay in their profiles (EMBRAPA, 2018).

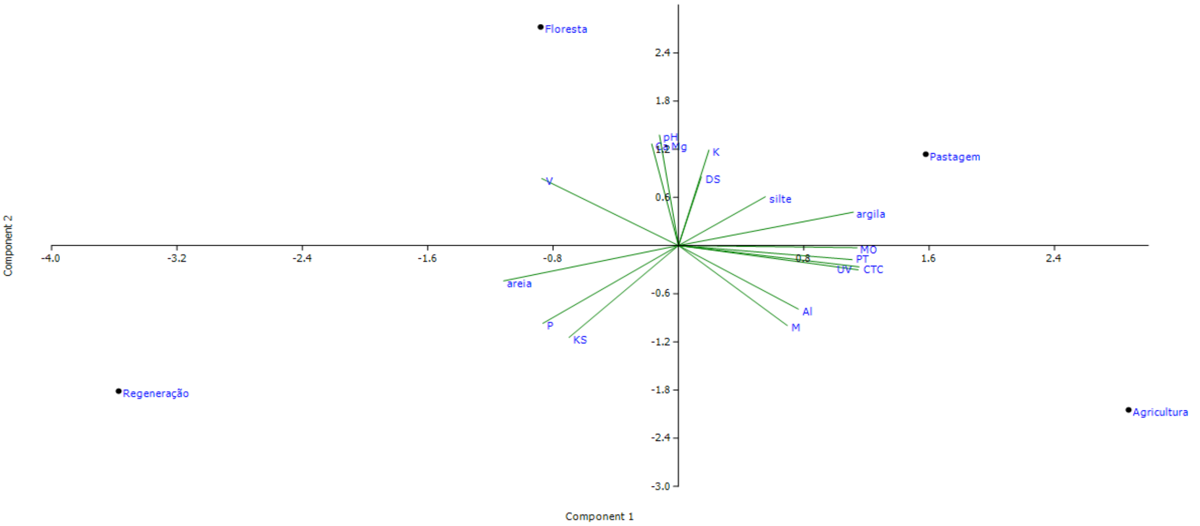

Figure 2. Ordering diagram resulting from the application of principal component analysis to soil attribute data from regenerating pasture, forest, agriculture and cerrado areas.

Original variables	Axle 1	Axle 2	Axle 3
DS	0.043	0.256	-0.501
PT	0.332	-0.052	-0.190
KS	-0.209	-0.343	0.065
UV	0.343	-0.090	0.004
Argila	0.334	0.124	-0.062
Silte	0.166	0.182	0.487
Areia	-0.334	-0.131	0.030
P	-0.259	-0.290	-0.027
K	0.058	0.356	0.338
V	-0.261	0.250	0.209
M	0.208	-0.298	0.258
MO	0.341	-0.008	-0.149
CTC	0.345	-0.079	0.014
Ca+Mg	-0.051	0.379	0.284
Al	0.229	-0.237	0.328
pH	-0.036	0.412	-0.168

Table 3. Matrix of correlation coefficients between eigenvectors 1, 2 and 3 and the original variables.

Neosols are shallow, young soils, with little structure and consistency, with little or no resistance to structuring to the touch, typical of soils with a predominance of quartz sands (EMBRAPA, 2018).

As shown in the ordination diagram, the highest levels of potassium (K) were verified in the degraded pasture area, this verified increase may be due to the amount of K deposited by the feces of bovine animals. According to Silva et al. (2014) cattle manure, after 270 days of contact with the soil, releases 80% of its total K content in the soil, that is, for every 2 tons/hectare of cattle manure, 7.5 g/ kg of K.

As for the pasture area, this has the highest soil density, as well as clay content and potassium concentration. Regarding the agricultural area under conventional cultivation, the high concentration of aluminum in the form of Al^3 and in saturation (m%) stood out, as well as C.T.C., volumetric humidity, organic matter and total porosity.

CONCLUSION

Each land use in the Cerrado biome presented chemical and physical results that were quite different from each other. The area under regeneration stood out with the hydraulic conductivity index, due to the higher percentage of sand. The planted forest has greater fertility, highlighting the V% and the Ca+Mg and pH contents.

REFERENCES

AQUINO, A. M.; ALMEIDA, D. L.; GUERRA, J. G. M.; DE-POLLI, H. Biomassa microbiana, colóides orgânicos e nitrogênio inorgânico e vermicompostagem de diferentes substratos. **Pesq. agropec. bras., Brasília**, v.40, n.11, p.1087-1093, 2005.

ARAÚJO, R. GOEDERT, W. J.; LACERDA, M. P. C. R. Qualidade de um solo sob diferentes usos e sob cerrado nativo. **Revista Brasileira de Ciência do Solo**, 31: 1099-1108, 2007.

BENITES, V. M.; MOUTTA, R. O.; COUTINHO, H. L. C; BALIEIRO, F.C. Análise discriminante de solos sob diferentes usos em área de Mata Atlântica a partir de atributos da matéria orgânica. **Revista Árvore**, v. 34: 685-90, 2010.

CAVENAGE, A.; MORAES, M.L.T.; ALVES, M.C.A.; CARVALHO, M.A.C.; FREITAS, M.L.M.; BUZETTI, S. Alterações nas propriedades físicas de um Latossolo Vermelho-Escuro sob diferentes culturas. **Revista Brasileira de Ciência do Solo**, Viçosa, v.23, n.4, p.997-1003, 1999.

DUMANSKI, J.; PIERI, C. **Land quality indicators: research plan. Agriculture Ecosystems & Environment.** 81:155-162, 2000.

EMBRAPA. **Centro Nacional de Pesquisa de Solos. Manual de métodos de análise de solos.** 3ª ed. rev. Rio de Janeiro: EMBRAPA, p. 573, 2017.

EMBRAPA. **Sistema Brasileiro de Classificação de Solos.** 5ª edição revista e ampliada. Brasilia – DF: EMBRAPA, 2018.

FIORI, J. P. O.; CAMPOS, J. E. G.; ALMEIDA, L. Variabilidade da condutividade hidráulica das principais classes de solo do Estado de Goias. São Paulo, UNESP, **Geociências**, v. 29, n. 2, p. 229-235, 2010.

HAMMER, Ø.; HARPER, D. A. T.; RYAN, P. D. Past: Paleontological statistics software package for education and data analysis. **Palaeontologia Electronica**, v. 4(1): 1-9, 2001.

MARCHESAN, T.M.; SOUZA, A.M.; MENEZES, R. Avaliação do processo de ensino: uma abordagem multivariada. **Produção**.; v. 21: 271-83, 2011.

SANTOS, R. D.; SANTOS, H. G.; KER, J. C.; ANJOS, L. H. C.; SHIMIZU, S. H. **Manual de Descrição de e Coleta de Solo no Campo.** 6ª ed. rev. Ampl. – Viçosa, MG: Sociedade Brasileira de Ciências do Solo, 2013.

SEPLAN – Secretaria do Planejamento e da Modernização da Gestão Pública, 2012. Disponível em: < https://seplan.to.gov.br/zoneamento/mapas/estado-do-tocantins/ > Acessado em 12 de Abril de 2018.

SILVA, V. B.; SILVA, A. P.; DIAS, B. O.; ARAUJO, J. L.; SANTOS, D.; FRANCO, R. P. Decomposição e liberação de N, P e K de esterco bovino e de cama de frango isolados ou misturados. **Revista Brasileira de Ciências do Solo**, 38:1537-1546, 2014.

SOUZA, Z. M., SILVA, M. L. S.; GUIMARÃES, G. L.; CAMPOS, D. T. S.; CARVALHO M. P.; PEREIRA, G. T. Variabilidade espacial de atributos físicos em um Latossolo Vermelho distrófico sob semeadura direta em Selvíria (MG). **Revista Brasileira de Ciência do Solo**, 25: 699-707, 2001.

STONE, L. F.; SILVEIRA, P. M. **Efeitos do sistema de preparo e da rotação de culturas na porosidade e densidade do solo. Revista Brasileira de Ciências do Solo**, 25: 395-401, 2001.

VEIGA, M. Propriedades de um Nitossolo Vermelho após nove anos de uso de sistemas de manejo e efeito sobre culturas. Universidade Federal de Santa Maria, 2005. 110p. (**Tese de Doutorado**).